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~~SUPERSEDED~~
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(See 6.5)

MILITARY SPECIFICATION
FIRE EXTINGUISHING AGENT, AQUEOUS FILM FORMING
FOAM (AFFF) LIQUID CONCENTRATE, SIX PERCENT,
FOR FRESH AND SEA WATER

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers the requirements for aqueous film forming foam (AFFF) liquid concentrate fire extinguishing agent consisting of fluorocarbon surfactants and foam stabilizers. The liquid concentrate will be diluted for use in concentrations of six parts concentrate to ninety-four parts fresh or sea water by volume. Certain shipboard proportioning equipment can produce foam at concentration extremes of 3 percent and 50 percent; requirements for such concentrations are specified herein.

2. APPLICABLE DOCUMENTS

2.1 Issues of documents. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

~~SPECIFICATIONS~~

FEDERAL

O-D-1407 - Dry Chemical, Fire Extinguishing, Potassium Bicarbonate.
NN-P-71 - Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).
RR-S-366 - Sieve, Test.
TT-E-489 - Enamel, Alkyd, Gloss (For Exterior and Interior Surfaces).
VV-G-76 - Gasoline, Automotive.
PPP-C-1337 - Containers, Metal, With Polyethylene Inserts.

MILITARY

MIL-G-5572 - Gasoline, Aviation, Grades 80/87, 100/130, 115/145.

STANDARDS

FEDERAL

FED-STD-595 - Colors.

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-130 - Identification Marking of U.S. Military Property.
MIL-STD-147 - Palletized Unit Loads for 40" x 48" Pallets.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, D. C. 20362, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4210

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PUBLICATIONS

MILITARY

DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER (DTNSRDC)
Standard Marine Bioassay Procedure for Shipboard Chemicals.

(Application for copies should be addressed to Commander, David W. Taylor Naval Ship Research and Development Center, (Code 2853), Annapolis, Maryland 21402.)

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA No. 412 - Evaluating Foam Fire Equipment on Aircraft Rescue and Fire Fighting Vehicles.

(Application for copies should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D96-73 - Water and Sediment in Crude Oils.

D445-74 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).

D1141 - Substitute Ocean Water.

D1331 - Surface and Interfacial Tension of Solutions of Surface-Active Agents.

D1821 - Inorganic Chlorides in Asphalts.

E527 - Numbering Metals and Alloys (UNS).

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

AMERICAN PUBLIC HEALTH ASSOCIATION

Standard Methods for the Examination of Water and Waste Water, 13th Edition.

(Application for copies should be addressed to the American Public Health Association, 1015 - 18th Street, N.W., Washington, D.C. 20036.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification Ratings, Rules, and Regulations.

(Application for copies should be addressed to the Uniform Classification Committee Agent, G. F. Earl, Tariff Publication Officer, Room 1106, 222 South Riverside Plaza, Chicago, Illinois 60606.)

DEPARTMENT OF TRANSPORTATION

Code of Federal Regulations, Title 49.

(Application for copies should be addressed to the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Qualification. Liquid concentrate fire extinguishing agents furnished under this specification shall be products which are qualified for listing on the applicable Qualified Products List at the time set for opening of bids (see 4.3 and 6.3).

3.2 Materials. The concentrate shall consist of fluorocarbon surfactants plus other compounds as required to conform to the requirements specified hereinafter. The material shall have no adverse effect on the health of personnel when used for its intended purpose.

3.3 Refractive index. When tested in accordance with 4.7.1, the concentrate shall have a minimum refractive index of 1.3580.

3.4 Viscosity. When tested in accordance with 4.7.2, the concentrate shall have a maximum viscosity of 30 centistokes (cs) and a minimum viscosity of 2 cs.

3.5 Hydrogen ion concentration (pH). When tested in accordance with 4.7.3, the concentrate shall have a pH value of between 7.0 and 8.5.

3.6 Spreading coefficient. When tested in accordance with 4.7.4, a 6-percent AFFF-water solution shall have a minimum spreading coefficient of plus 3.0.

3.7 Foamability. When tested in accordance with 4.7.5, 6-percent by volume solutions of fresh water and sea water shall produce foams with a minimum expansion of 6.0 and a minimum 25-percent drainage time of 2.5 minutes.

3.8 Film formation and sealability. When tested in accordance with 4.7.6, the foam-produced film shall spread over the fuel surface and prevent sustained ignition.

3.9 Fire performance.

3.9.1 General. Fire performance shall be determined by extinguishing fires on three different size areas: 28, 50, and 1260 square feet. Extinguishment shall be by application of foams made from solutions prepared from the concentrate and fresh water or sea water, as specified herein.

3.9.2 Twenty-eight-square-foot fire requirement. When tested in accordance with 4.7.7, the specified performance levels shall be met.

3.9.2.1 Three-percent AFFF solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. The fire shall be extinguished within a foam application time of 65 seconds, and the resulting foam cover shall exhibit a burnback time of at least 240 seconds.

3.9.2.2 Six-percent AFFF solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. The fire shall be extinguished within a foam application time of 45 seconds and the resulting foam cover shall exhibit a burnback time of at least 320 seconds.

3.9.2.3 Fifty-percent AFFF solutions. A minimum of one fire test with sea water shall be conducted. The fire shall be extinguished within a foam application time of 55 seconds and the resulting foam cover shall exhibit a burnback time of at least 100 seconds.

3.9.3 Fifty-square-foot fire requirement. When tested in accordance with 4.7.8, 85-percent of the fire area shall be extinguished within a foam application time of 40 seconds, and the resulting foam cover shall exhibit a burnback time of at least 240 seconds. The 40 second summation shall be a minimum of 225. A minimum of one fire test with a 6-percent AFFF sea water solution shall be conducted.

3.9.4 Twelve hundred sixty-square-foot fire requirement. When tested in accordance with 4.7.9, the specified performance levels shall be met.

3.9.4.1 Three-percent AFFF solution. A minimum of one fire test with sea water shall be conducted. Eighty-five percent of the fire area shall be extinguished within a foam application time of 40 seconds and the 40-second summation shall be a minimum of 285.

3.9.4.2 Six-percent AFFF solutions. A minimum of one fire test each with fresh water and sea water shall be conducted. Eighty-five percent of the fire area shall be extinguished within a foam application time of 30 seconds and the 40-second summation shall be a minimum of 285.

3.9.4.3 Fifty-percent AFFF solution. A minimum of one fire test with sea water shall be conducted. Eighty-five percent of the fire area shall be extinguished within a foam application time of 55 seconds, and the 40-second summation shall be a minimum of 225.

3.10 General corrosion. When tested in accordance with 4.7.10, the corrosion rate shall not exceed 5.0 milli-inches per year (mpy) for cold rolled, low carbon steel, Unified Numbering System (UNS) G10100; 3.0 mpy for 90-10 copper-nickel alloy, UNS C70600; 1.5 mpy for 70-30 nickel-copper, UNS N04400; and 300 milligrams (mg) for cast tin bronze, UNS C90500. (The nominal compositions of UNS metals and alloys are given in ASTM E527.)

3.11 Localized corrosion. When tested in accordance with 4.7.11, corrosion-resistant steel UNS S30400, specimens shall show no evidence of pitting.

3.12 Total halides. When tested in accordance with 4.7.12, the total halides content of the concentrate shall not exceed 100 parts per million (p/m).

3.13 Dry chemical compatibility. When tested in accordance with 4.7.13, the foam cover shall exhibit a burnback resistance time of at least 320 seconds.

3.14 Stability. Stability shall be determined by testing the concentrate, fresh water premix solution, and sea water premix solution, as specified, after a high temperature holding period in accordance with 4.7.14.

3.14.1 Spreading coefficient. When tested in accordance with 4.7.14.2, all samples shall still meet the requirement of 3.6.

3.14.2 Foamability. When tested in accordance with 4.7.14.3, all samples shall still meet the requirements of 3.7.

3.14.3 Film formation and sealability. When tested in accordance with 4.7.14.4, all samples shall still meet the requirement of 3.8.

3.14.4 Fire performance.

3.14.4.1 Three-percent AFFF solutions. When tested in accordance with 4.7.14.5, 3-percent AFFF fresh water and sea water solutions freshly prepared from aged concentrate shall still meet the requirements of 3.9.2.1.

3.14.4.2 Six-percent AFFF solutions. When tested in accordance with 4.7.14.5, 6-percent AFFF fresh water and sea water solutions aged as premix solutions shall still meet the requirements of 3.9.2.2.

3.14.5 Stratification. When tested in accordance with 4.7.14.6, there shall be no visual evidence of stratification.

3.14.6 Precipitation. When tested in accordance with 4.7.14.7, any precipitation shall not exceed 0.05 percent by volume.

3.15 Compatibility. The concentrate of one manufacturer shall be compatible in all proportions with concentrate furnished by other manufacturers listed on the qualified products list. The material shall also be compatible with material in inventory which was procured under previous issues of this specification. Information regarding these materials may be obtained from NAVSEC. Compatibility shall be determined in accordance with 4.7.15.

3.15.1 Viscosity. When tested in accordance with 4.7.15.2, the viscosity of the mixtures of the concentrates shall not be greater than the most viscous of the constituents or less than the least viscous of the constituents.

3.15.2 Spreading coefficient. When tested in accordance with 4.7.15.3, all samples shall meet the requirements of 3.6.

3.15.3 Foamability. When tested in accordance with 4.7.15.4, all samples shall meet the requirements of 3.7.

3.15.4 Film formation and sealability. When tested in accordance with 4.7.15.5, all samples shall meet the requirements of 3.8.

3.15.5 Fire performance. When tested in accordance with 4.7.15.6, all samples shall meet the requirements of 3.9.2.2.

3.15.6 Stratification. When tested in accordance with 4.7.15.7, all samples shall meet the requirements of 3.14.5.

3.15.7 Precipitation. When tested in accordance with 4.7.15.8, all samples shall meet the requirements of 3.14.6.

3.16 Environmental impact.

3.16.1 Toxicity. The concentrate shall have a TL_{50} of not less than 1500 p/m when tested as specified in 4.7.16.

3.16.2 Biological oxygen demand (BOD₂₀). The concentrate 20-day BOD₂₀ shall not exceed 500,000 milligrams per liter (mg/L) when tested as specified in 4.7.16.

3.16.3 Chemical oxygen demand (COD). The concentrate COD shall not exceed 500,000 mg/L when tested as specified in 4.7.16.

3.17 Marking.

3.17.1 Identification marking shall be in accordance with MIL-STD-130. In addition, the marking on the containers (see 5.3) shall be in white characters against a blue background (see 5.1.1.3).

3.17.2 Two identical markings conforming to figure 1 shall be applied to containers so that the markings are located diametrically opposite. The markings shall be applied on the containers in such a manner that water immersion contact with the contents of the containers, or normal handling will not impair the legibility of the marking. Paper labels shall not be used.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) Qualification inspection (see 4.3).
- (b) Quality conformance inspection (see 4.6).
 - (1) Examination of filled containers.
 - (2) Quality conformance tests.

4.2.1 Test reports. The contractor shall prepare quality conformance test reports in accordance with the data ordering document included in the contract or order (see 6.2.2).

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory satisfactory to the Naval Ship Engineering Center. Qualification tests shall consist of the tests specified in table I.

4.3.1 Samples for qualification tests. Forty 5-gallon containers (200 gallons) are required for the qualification tests.

4.4 Inspections. The tests and examinations applicable to each classification shall be as shown in table I:

TABLE I. Quality conformance and qualification inspections.

| Examination or test | Reference paragraph | | Qualification | Quality conformance |
|----------------------------------|---------------------|---------|---------------|---------------------|
| | Requirement | Test | | |
| Refractive index | 3.3 | 4.7.1 | X | X |
| Viscosity | 3.4 | 4.7.2 | X | X |
| pH value | 3.5 | 4.7.3 | X | X |
| Spreading coefficient | 3.6 | 4.7.4 | X | X |
| Foamability | 3.7 | 4.7.5 | X | X |
| Film formation and seal | 3.8 | 4.7.6 | X | X |
| 28 ft ² fire test | 3.9.2 | 4.7.7 | X | X |
| 50 ft ² fire test | 3.9.3 | 4.7.8 | X | |
| 1260 ft ² fire test | 3.9.4 | 4.7.9 | X | X |
| General corrosion | 3.10 | 4.7.10 | X | |
| Localized corrosion | 3.11 | 4.7.11 | X | |
| Total halides | 3.12 | 4.7.12 | X | |
| Dry chemical compatibility | 3.13 | 4.7.13 | X | |
| Stability | 3.14 | 4.7.14 | X | |
| Compatibility | 3.15 | 4.7.15 | X | |
| Environmental effect | 3.16 | 4.7.16 | X | |
| Examination of filled containers | | 4.6.1 | | |
| Torque to remove cap | | 5.1.1.1 | X | |

4.5 Sampling for quality conformance inspection.

4.5.1 Inspection lot. A lot shall consist of all material manufactured as one batch and transferred from one mixing tank to the shipping container.

4.5.2 Sampling for examination of filled containers. A random sample of filled containers shall be selected from each lot in accordance with MIL-STD-105 at inspection level I. The acceptable quality level (AQL) of 2.5 percent defective shall be used to verify compliance with all requirements regarding fill, closure, marking, and other requirements not requiring tests, as specified in 4.6.1, 5.1.1.1, and 5.1.1.2.

4.5.3 Sampling for quality conformance tests. Three filled 5-gallon containers shall be selected at random from each lot and used as one composite sample for the tests specified in 4.6.2, or three 5-gallon containers of the product shall be withdrawn from an agitated mixing tank prior to packaging. The results of the tests required by 4.6.2 shall be submitted to a laboratory designated by NAVSEC.

4.6 Quality conformance inspection.

4.6.1 Examination of filled containers. Each sample filled container shall be examined for defects of construction of the container and the closure, for evidence of leakage, and for unsatisfactory markings. Each filled container shall also be weighed to determine the amount of contents. Any container in the sample having one or more defects or less than required fill, shall not be offered for delivery, and if the number of defective containers in any sample exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, this shall be cause for rejection of the lot represented by the sample.

4.6.2 Quality conformance tests. The samples selected in accordance with 4.5.3 shall be subjected to the tests of table I, as applicable.

4.6.2.1 Action in case of failure. If the sample tested is found to be not in conformance with any requirement of this specification, the lot represented by the sample shall be rejected.

4.7 Test procedures.^{1/}

4.7.1 Refractive index. The refractive index shall be determined at $25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$, using sodium vapor source lamp illumination.

4.7.2 Viscosity. The viscosity shall be determined at temperatures of $5^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ and $25^{\circ}\text{C} \pm 0.1^{\circ}\text{C}$ in accordance with ASTM D445-74, using capillary viscosimeters in the appropriate size.

4.7.3 pH value. The pH value shall be determined potentiometrically, using a pH meter with a glass electrode and a reference electrode, at $25^{\circ}\text{C} \pm 1.0^{\circ}\text{C}$.

4.7.4 Spreading coefficient. The spreading coefficient shall be determined with reference to cyclohexane in accordance with the following relationship:

$$S_{a/b} = \gamma_b - \gamma_a - \gamma_i$$

where $S_{a/b}$ = spreading coefficient
 γ_b = surface tension of cyclohexane as determined in 4.7.4.1
 γ_a = surface tension of AFFF solution as determined in 4.7.4.1
 γ_i = interfacial tension between liquids as determined in 4.7.4.2

4.7.4.1 Surface tension. The surface tension of a 6 ± 0.1 percent by volume of the concentrate in distilled water and of reagent grade cyclohexane shall be determined with a DuNoy tensiometer, or equal, at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ in accordance with ASTM D1331.

4.7.4.2 Interfacial tension. The interfacial tension between reagent grade cyclohexane and a 6 ± 0.1 percent by volume of the concentrate in distilled water shall be determined in a DuNoy tensiometer, or equal, at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$ until the readings come to equilibrium and in accordance with ASTM D1331.

4.7.5 Foamability. The foam shall be generated by means of a special 2 gallons per minute (gal/min) test nozzle. The basic nozzle as made by National Foam System, Inc., Lionville, Pennsylvania, (or equal) shall be modified by shortening the length of the foam barrel from 2-1/2 to 1-1/4 inches, and by adding a "wing-tip" spreader on the outlet. The spreader shall have a 1/8 inch wide, circular orifice, 1-7/8 inches long. (It may be made by slightly compressing a Bernz-o-matic TX-1527 or equal flame spreader). A print of the nozzle construction is available from the Naval Research Laboratory, Code 6180, Washington, D.C. 20375. During foam sample collection, the nozzle butt pressure shall be maintained at a gage pressure of 100 pounds per square inch (lb/in^2), and the solution temperature at $23^{\circ}\text{C} \pm 2.0^{\circ}\text{C}$. The nozzle shall be held at hip height and directed onto the backboard from a distance of 4 - 6 feet. The method and procedure shall be in accordance with NFPA Standard No. 412.

4.7.6 Film formation and sealability. The purpose of the test is to determine the ability of the foam to generate a film over the fuel surface capable of sealing off vapor production.

4.7.6.1 Test equipment. A corrosion-resistant (CRES) graduated measure of 1000 milliliter (mL) capacity (4-1/2 inches in diameter, 5 inches deep; Cole-Parmer Co., Chicago, Illinois or equal) shall be fitted with two retaining clips at the top edge. The clips shall serve to restrain a cone 5 inches in height and 4-3/4 inches in diameter, made of 80-mesh perforated CRES in an inverted position inside the measure. The 2 gal/min nozzle specified in 4.7.5 shall be used for foam production.

4.7.6.2 Test procedure. After placing 600 mL of 98-percent cyclohexane in the measure, 200 mL of freshly-made foam shall be poured onto the fuel. The inverted cone shall be pushed down into the measure, thereby pushing most of the foam aside but allowing the

^{1/}Where sea water is required for tests, synthetic sea water in accordance with ASTM D1141 shall be used. A sea salt mixture conforming to this standard may be purchased from Lake Products Company, Inc., St. Louis, Missouri 63125.

film-producing liquid to creep in through the mesh openings. A foam-free surface shall be created by manually scooping out most of the residual foam from the center of the cone. After a 1-minute waiting period, a pilot flame shall be passed over the fuel surface at a height of about 1/2 inch. A small flash is permitted, but no sustained ignition shall result, if an effective vapor seal is present. A 1-inch long pilot flame shall be provided with a hand-held propane cylinder fitted with a capillary tubing outlet.

4.7.7 Twenty-eight-square-foot fire test.

4.7.7.1 Test equipment. The fire test shall be conducted in a circular pan 6 feet in diameter, fabricated from 1/4-inch thick steel with a 4-inch high side. A shallow water layer shall be used to protect the pan bottom and to ensure complete coverage of the area with fuel. The nozzle used for foam application shall be the 2 gal/min device specified in 4.7.5.

4.7.7.2 Test materials. Foam shall be generated from 3 ± 0.05 percent, 6 ± 0.1 percent, and 50 ± 0.1 percent AFFF solutions made with fresh water and sea water at $23^{\circ}\text{C} \pm 5.0^{\circ}\text{C}$. The fuel shall be 10 gallons of motor gasoline conforming to VV-G-76.

4.7.7.3 Test procedure. No tests shall be conducted when the wind speed is above 10 miles per hour (mph). The fuel shall be dumped within a 30 second period. The fuel shall be ignited within 30 seconds of fueling and allowed to burn freely for 10 seconds. After the preburn period, the fire shall be attacked and extinguished as expeditiously as possible and the fire extinguishing time shall be recorded at the exact cessation of all flame, but foam application shall continue until 90 seconds have elapsed.

4.7.7.4 Burnback procedure. Within 60 seconds of the completion of foam application, a burning pan (1-foot diameter, 2-inch side) shall be placed in the center of the 28-square-foot pan and a timer started. When it appears that the fire has spread outside the pan so that burning will continue after pan removal, the pan shall be removed. The burnback time is that time at which it is estimated that 7 square feet (25 percent) of the total area is involved in flames.

NOTE: Intermittent "flash-overs" may occur. They are characterized by creeping faint blue or invisible flames over the foam surface which usually self-extinguish. They are not considered a part of the burnback area unless sustained burning occurs. All isolated, sustained burning areas should be included in arriving at the 7-square-foot total area.

4.7.8 Fifty-square-foot fire test.

4.7.8.1 Test site. The fire test shall be conducted on a level, circular area 8 feet in diameter. The base and surrounding wall shall be suitable for containment of the fuel on a substrate of water. The water depth shall be the minimum required to ensure complete coverage with the fuel.

4.7.8.2 Test equipment. The nozzle used for foam application shall be the 2 gal/min device specified in 4.7.5, operated at a gage pressure of 100 lb/in^2 .

4.7.8.3 Test materials. The foam shall be generated from a 6 ± 0.1 percent, $20^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ AFFF solution made with sea water. The fuel shall be 15 gallons of gasoline conforming to MIL-G-5572 or VV-G-76.

4.7.8.4 Test procedure. No tests shall be conducted when the wind speed is above 10 mph. The fuel shall be dumped into the area within 60 seconds and ignited within 30 seconds of dumping. After allowing a preburn period of 10 seconds, the fire shall be attacked and extinguished in an expeditious manner. At 10-second intervals after the start of foam application, observers shall estimate the percentage of fire area extinguished. The percentages at 10, 20, 30, and 40 seconds shall be totaled to give the "40 second summation" value. The exact extinguishing time shall also be recorded at the cessation of all flame, but foam application shall continue for a full 90 seconds.

4.7.8.5 Burnback procedure. Within 60 seconds of the completion of foam application, a burnback test shall be conducted as specified in 4.7.7.4, except that the burnback area shall be 12.5 square feet (25 percent).

4.7.9 Twelve-hundred-sixty-square-foot fire test.

4.7.9.1 Test site. The fire test shall be conducted on a level, circular area 40 feet in diameter. The base and surrounding dike shall be suitable for the containment of the fuel on a substrate of water. The water depth shall be the minimum required to ensure complete coverage of the area with fuel.

4.7.9.2 Test equipment. The nozzle used for foam application shall be Elkhart Brass Manufacturing Company, Inc., Elkhart, Indiana 46514, Model "SFL" or equal, set to discharge at a rate of 60 gpm at a gage pressure of 100 lb/in².

4.7.9.3 Test materials. Foams shall be generated from 3 + 0.05 percent, 6 + 0.1 percent, and 50 + 0.1 percent AFFF solutions made from fresh water and sea water at 20°C + 0.5°C. The fuel shall be 300 gallons of gasoline conforming to MIL-G-5572.

4.7.9.4 Test procedure. No tests shall be conducted when the wind speed is above 10 mph. The fuel shall be dumped and ignited with a minimum of delay. After allowing a preburn period of 10 seconds, the fire shall be attacked and extinguished in an expeditious manner. At 10-second intervals after the start of foam application, observers shall estimate the percentage of fire area extinguished. The percentages at 10, 20, 30, and 40 seconds shall be totaled to give the "40-second summation" value. The time of foam application required to achieve extinguishment of 85 percent of the area shall also be recorded.

4.7.10 General corrosion.

4.7.10.1 Test medium. The liquid for immersion of the metal specimens shall consist of the concentrate diluted by 10 percent by volume with sea water.

4.7.10.2 Test specimens. The test specimens shall consist of the following metals, in accordance with UNS designations (see ASTM E527): G10100 steel, C70600 copper-nickel alloy, N04400 nickel-copper and C90500 bronze. All specimens, except the bronze, shall be milled to finished dimensions of approximately 1/16 inch thick, 1/2 inch wide, and 3 inches long. The bronze shall have sand cast faces and be approximately 3/16 inch thick, 1/2 inch wide, and 3 inches long. All specimens shall be degreased in acetone, rinsed with distilled water and air dried before exposure. (Prepared metal specimens may be obtained from the Metaspec Company, Box 28125, San Antonio, Texas 78228.)

4.7.10.3 Test procedures. Five weighed specimens of each metal shall be fully immersed in the test medium in a separate 600 mL beaker and held at room temperature for a period of 60 days. A watch-glass cover shall be used to retard evaporation. At the end of the exposure period, the weight-loss shall be determined and the corrosion rate calculated as required.

4.7.11 Localized corrosion.

4.7.11.1 Test medium (see 4.7.10.1).

4.7.11.2 Test specimens. The test specimens shall consist of UNS S30400 stainless steel milled to finished dimensions of approximately 1/16 inch thick, 1/2 inch wide, and 3 inches long. After degreasing with acetone and rinsing with water, the specimens shall be pretreated by immersion in a 1:9 concentrated nitric acid-water solution for a period of 5 minutes.

4.7.11.3 Procedure. Ten specimens shall be girdled lengthwise with a clean 1/16 to 1/8 inch wide band of a good grade of gum rubber of a size such that the band is taut during the test. Because of the poor quality of most commercial rubber bands, it is recommended that the bands for this test be cut from 1-3/4-inch flat width pure gum amber tubing. Gooch type (Preiser Scientific Rubber tubing, Pure Gum, Gooch type, 1/32-inch thin wall, pure gum amber tubing, very elastic, especially made for Gooch crucibles, Stock No. 139080 or equal). This tubing is most easily cut into uniform strips with a blade-type papercutter, but can also be cut with sharp shears. The specimens with their rubber bands shall be placed in a 600 mL beaker so that no contact is made between individual specimens. A 1/4-inch layer of glass beads shall be introduced into the beaker to aid in stabilizing specimen position. Enough liquid shall be added to completely immerse the specimens, and a watch-glass shall be placed over the beaker to retard evaporation (but allow air access) and act as a dust cover, and the assemblies allowed to stand at room temperature for 60 days.

4.7.11.4 Results. The specimens shall be monitored daily over the 60-day period to ascertain the presence or absence of pitting. These daily examinations shall be made without disturbing the test (other than removing the cover). Corrosion is customarily signaled by the appearance of a dark spot which, if removed after sufficient exposure, discloses a corrosion pit. If the suspected area cannot be positively identified by the naked eye, it can be at a magnification of 10X. At the end of the test, each specimen shall be inspected carefully with particular attention being given to the edges of the specimens and those areas of the specimens under, or adjacent to the rubber bands. 10X magnification shall be used, if necessary.

4.7.12 Total halides. The halide content shall be determined to be in accordance with ASTM D1821, except for the following modifications:

(a) Procedure:

(1) Weight 2 ± 0.1 g or add 2 ± 0.1 mL of concentrate into a 250 mL beaker.

(2) Add 75 mL of acetone. Add 2 mL of dilute nitric acid (1 volume of concentrated acid to 60 volumes of water).

(b) The calculation shall be modified as follows:

$$\text{halide content, p/m} = 44.4(A-B)$$

4.7.13 Dry chemical compatibility. The foam's compatibility with potassium bicarbonate dry chemical extinguishing agent shall be determined by measuring the burnback time in the presence of dry chemical.

4.7.13.1 Test materials. The fuel shall be gasoline conforming to VV-G-76. The dry chemical agent shall conform to O-D-1407. The sieve shall be an 8-inch diameter, 40 mesh sieve conforming to type I, style A of RR-S-366.

4.7.13.2 Test procedure. A 28-square-foot fire test shall be conducted in accordance with 4.7.7, using a 6-percent AFFF sea water solution. Before placing the burning pan, one pound of dry chemical agent shall be evenly distributed over the foam blanket with the aid of the sieve on a handle. This shall be accomplished within a 30-second period so that the total time from end of foam application to placement of the burning pan will be no longer than 90 seconds. The burnback time shall be determined as in 4.7.7.4.

4.7.14 Stability.

4.7.14.1 Sample preparation. Samples of concentrate, 6 percent AFFF fresh water solution, and 6 percent AFFF sea water solution, shall be prepared in sufficient quantity to perform the required tests. One liter (L) of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at $65^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ for a period of 10 days prior to testing.

NOTE: In the preparation of the samples to be used for the precipitation test, the synthetic sea water shall be filtered prior to use.

4.7.14.2 Spreading coefficient. The spreading coefficient shall be determined in accordance with the procedure in 4.7.4, except that the 6 percent solutions shall not be further diluted.

4.7.14.3 Foamability. Foamability shall be determined in accordance with 4.7.5.

4.7.14.4 Film formation and sealability. The film formation and sealability shall be determined in accordance with 4.7.6.

4.7.14.5 Fire performance. The fire performance shall be determined by the 28 square-foot fire test in accordance with 4.7.7.

4.7.14.6 Stratification. The presence of stratification shall be determined by visual examination of the samples contained in the glass cylinders.

4.7.14.7 Precipitation. The amount of precipitation shall be determined by centrifuging the 1-liter samples in accordance with ASTM D96-73, (Method 4) using cone-shaped tubes, except that benzene shall not be used. The samples shall be thoroughly agitated before transferring to the centrifuge tubes.

4.7.15 Compatibility.

4.7.15.1 Sample preparation. Mixtures of the concentrates to be tested shall be prepared in sufficient quantities to perform the required tests. (For qualification testing, the testing activity will determine the number and compositions of the mixtures.) Additionally, 6 percent AFFF fresh water and sea water solutions shall be prepared from each concentrate mixture. One L of each shall be placed in lightly stoppered glass cylinders. All samples shall then be stored at $65^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ for a period of 10 days prior to testing.

4.7.15.2 Viscosity. The viscosities of all of the mixtures of concentrates shall be determined in accordance with 4.7.2 at 25°C .

4.7.15.3 Spreading coefficient. The spreading coefficient of all samples shall be determined in accordance with 4.7.4, except that the 6 percent AFFF solutions shall not be further diluted.

4.7.15.4 Foamability. The foamability of all samples shall be determined in accordance with 4.7.5.

4.7.15.5 Film formation and sealability. The film formation of all samples shall be determined in accordance with 4.7.6.

4.7.15.6 Fire performance. The fire performance of all samples shall be determined in accordance with the 28 square foot fire test in 4.7.7.

4.7.15.7 Stratification. The stratification of all samples shall be determined in accordance with 4.7.14.6.

4.7.15.8 Precipitation. The precipitation shall be determined in accordance with 4.7.14.7.

4.7.16 Environmental impact. All environmental tests shall be made in accordance with the procedures specified in the Standard Marine Bioassay Procedure for Shipboard Chemicals; the test organism shall be the killiefish (*fundulus heteroclitus*). Biological oxygen demand and chemical oxygen demand shall be determined in accordance with the procedures specified in Standard Methods for the Examination of Water and Waste Water, 13th edition.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation-packaging. Preservation-packaging for levels A and C shall be as specified hereinafter.

5.1.1 The AFFF liquid concentrate shall be furnished in a 5-gallon plastic or in a 55-gallon composite container as specified (see 6.2.1).

5.1.1.1 Five-gallon plastic container. The container shall be molded polyethylene as specified herein. The container shall be as follows:

| | |
|----------------------------|-----------------------------|
| Capacity | 5-gallon (min.) |
| Height, body (overall) | 14-1/4 inches (approximate) |
| Diameter, body (overall) | 11 inches (approximate) |
| Pour opening (inside dim.) | 1-1/2 inches (min.) |

5.1.1.1.1 The container shall meet the requirements of Department of Transportation Specification Number 34 as specified in the Code of Federal Regulations, Title 49, Part 178.19, and as follows:

- (a) Shall be stackable and self-supporting.
- (b) Shall be provided with a threaded-type plastic cap fitted with a gasket for the pour opening.
- (c) May be provided with a vent opening having an easily punctured membrane. When furnished, vent opening shall be provided with a threaded type plastic cap.
- (d) Shall be provided with an integrally molded or recessible plastic or metal handle. Metal handles shall not exceed a magnetic permeability of 2.0.

- (e) Shall have a blue color conforming to 5.1.1.3.
- (f) The torque required to remove the pour opening cap shall not exceed 50 inch lbs.

5.1.1.2 Fifty-five gallon container. The 55-gallon container shall be a composite comprised of a plastic insert and a steel drum overpack. The composite container shall conform to the requirements of type II, class 4 of PPP-C-1337, and the following:

- (a) Insert. The insert shall contain two protruding openings in the top head - one 3/4-inch and one 2-inch. Openings shall be so designed that when positioned in the steel drum cover there will be no strain on the protruding openings. The protruding plastic openings shall be secured to the drum cover by means of lock or retaining rings and gaskets. Openings shall be closed by use of NPT threaded plastic plugs.
- (b) Covers. The steel drum cover shall be provided with two openings to accommodate the protruding insert openings. Covers shall be fully removable. Cover gaskets are not required. Covers shall be secured to the steel drum with minimum 16-gage bolt or lever lock type locking rings.

5.1.1.3 Exterior color and coatings. Color shall be blue and shall be an approximate match to color number 15123 of FED-STD-595. Exterior coating for steel drum overpacks shall conform to TT-E-489. In case of question or dispute, a color chip shall be submitted to NAVSEC for resolution.

5.2 Packing. For levels A, B, and C, no further packing is required.

5.2.1 Method of shipment shall comply with Uniform Freight Classification Rules or other carrier rules as applicable to the mode of transportation.

5.2.2 Palletization. Thirty-six 5-gallon plastic containers shall be palletized in accordance with the requirements of MIL-STD-147, load type XVII. Pallets conforming to NN-P-71, type V, class 1, wood group optional, size 2, are acceptable. Containers shall be properly and firmly nested and arranged to insure a snug, non-shifting load. Pallet dimensions may be adjusted to assure a snug, non-shifting load, but shall not exceed 43 x 52 inches.

5.3 Marking. In addition to the marking specified in 3.17 and any special marking required (see 6.2.1), containers and palletized unit loads shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The concentrate is intended for use in mechanical foam generating equipment such as fire-fighting trucks or foam sprinkler systems for extinguishing fires in flammable liquids such as gasoline or fuel oils.

6.2 Ordering data.

6.2.1 Procurement requirements. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Size of container required (see 5.1.1).
- (c) Special marking, if required (see 5.3).

6.2.2 Data requirements. When this specification is used in a procurement which incorporates a DD Form 1423 and invokes the provisions of 7-104.9(n) of the Armed Services Procurement Regulation, the data requirements identified below will be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (DD Form 1423) incorporated into the contract. When the provisions of ASPR-7-104.9(n) are not invoked, the data specified below will be delivered by the contractor in accordance with the contract requirements. Deliverable data required by this specification is cited in the following paragraph:

| <u>Paragraph</u> | <u>Data requirement</u> | <u>Applicable DID</u> |
|------------------|-------------------------|-----------------------|
| 4.2.1 | Test reports | DI-T-2072 |

(Copies of data item descriptions required by the contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

6.3 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL 24385 whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Ship Engineering Center, SEC 6124, Department of the Navy, Washington, D. C. 20362, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification, SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification, SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material is procured by the contractor for incorporation into the foam and lose separate identity when the foam is shipped.

6.5 Changes from previous issue. The symbol "#" is not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

Custodians:

Navy - SH
Air Force - 99

Review activities:

Navy - AS, YD
Air Force - 04
DSA - CS

User activities:

Army - CE
Navy - MC, OS, CG

Preparing activity:

Navy - SH
(Project 4210-0304)

| |
|---|
| <p>THIS END UP</p> <p>U.S.</p> <p>AQUEOUS FILM FORMING FOAM (AFFF) LIQUID CONCENTRATE</p> <p>In accordance with</p> <p>MILITARY SPECIFICATION MIL-F-24385A</p> <hr/> <p>THIS FIRE EXTINGUISHING CONCENTRATE IS FOR USE BY DILUTION WITH WATER IN FIXED OR MOBILE SYSTEMS. IT MAY BE USED ALONE OR IN COMBINATION WITH "TWINNED" DRY CHEMICAL EQUIPMENT. THE CONCENTRATE MAY BE DILUTED FOR USE IN FLOW PROPORTIONING EQUIPMENT WITH SEA WATER OR FRESH WATER AT VOLUME PROPORTIONS OF SIX GALLONS CONCENTRATE TO 94 GALLONS WATER. IT MAY ALSO BE DILUTED FOR READY-USE STORAGE AS A SIX-PERCENT PREMIX SOLUTION WITH FRESH WATER.</p> <p>FOR READY USE DO NOT STORE BELOW 32°F. AVOID PROLONGED STORAGE ABOVE 120°F. DO NOT MIX WITH OTHER THAN LIQUID CONCENTRATE IN ACCORDANCE WITH MIL-F-24385A (AND PREVIOUS ISSUES) AND WATER.</p> <hr/> <p>MANUFACTURER'S NAME ADDRESS BATCH NO. DATE OF MANUFACTURE</p> |
|---|

FIGURE 1. Container markings.

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